MICRO-SCALE DISTRIBUTIONS OF MAJOR AND TRACE ELEMENTS IN CHONDRITES.

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Introduction: The Hayabusa spacecraft has successfully returned to Earth after two touchdowns on the surface of Asteroid 25143 Itokawa. This asteroid is classified as an S-type and inferred to consist of materials similar to ordinary chondrites or primitive achondrites [1]. More than 1500 particles have been identified consisting of olivine, pyroxene, plagioclase, Fe sulfide and Fe metal, with compositions consistent with being of LL origin. While the chondritic components are familiar to us, the level of detail to which the Itokawa samples will be exposed to will be unprecedented given that the samples are reasonably large and accessible to a wide variety of techniques. In many ways, we expect that our knowledge base of the comparator chondrites will be found to be wanting.

Chondrites are the building blocks of the solar system. However, these rocks are essentially breccias and they are quite variable in bulk element compositions as well as compositions of the individual components.

We have initiated a program of analysis for chondrites focusing on major and trace element distributions between the mineral components and the matrix. The issues to be addressed include the homogeneity of matrix and chondrule components and the representivity of any given sample to the bulk meteorite. This may be particularly important given the limited numbers of Itokawa grains that may be available for a specific analysis.

As an initial study, we have taken thin sections of carbonaceous chondrites to study the representivity of the matrix compositions. Spot locations were constrained to limited regions of the sections so as to assess the variability of a local scale. Further work will be required to assess variability over a centimeter scale.

Analytical Techniques: Major- and trace-element abundances were determined by SIMS through selection of appropriate isotopes. The SHRIMP RG at the ANU was used for this work. The reverse geometry allows full resolution of most molecular isobars while maintaining sensitivity. In addition, a low degree of energy filtering (ca. 30 eV) is applied to reduce matrix effects associated with the different mineral species.

Results: Preliminary results show that analyses of Allende (CV3), Murray (CM2) and Murchison (CM2) matrix show significant dispersion on the 20 µm sampling scale. For example in ^{26}Mg-Al-^{30}Si space (Figure 1), Allende analyses range from 0.05 to 0.60 in Al/^{30}Si likely reflecting the change in abundance of chondrule material in the analytical volume. However, there is little concomitant variation in ^{26}Mg/^{30}Si, which ranges from 0.46 to 0.51. For Murchison and Murray, the distribution is tighter with Al/^{30}Si ranging from 0.5 to 0.9, and ^{26}Mg/^{30}Si ranging from 0.35 to 0.45. For a limited number of analyses, Murchison appears to have higher ^{26}Mg/^{30}Si compared to Murray.

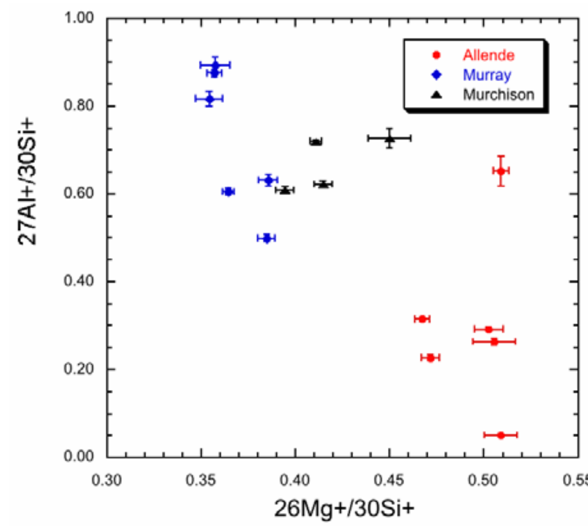

Figure 1. Al-Mg-Si ratios from matrix samples.

These results suggest that distinctive patterns could emerge from individual meteorites and that matrix alone may provide constraints as to the source meteorite. Such a finding could be important if matrix material is recovered from the returned Itokawa samples. However, significant dispersion is to be expected in any recovered matrix sample and so analysis of a single matrix sample may not be sufficient to constrain meteorite provenance.

References: [1] Abell P. A. (2007) *Meteorit. Planet. Sci.*, *42*, 2165–2177. [2] Abe M. et al. *Science*, *312*, 1334-1338. [3] http://www.jaxa.jp/press/2010/11/20101116_hayabusa_e.html, also abstracts in this conference.